GEOLOGY AND MINERALIZATION OF THE GATAGA RIVER AREA, NORTHERN ROCKY MOUNTAINS. (94L/7, 8, 9 AND 10)

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KEYWORDS: Northern Rocky Mountains, Gataga River, Kechika Trough, Hyland Group, Gog Group, Middle Cambrian, Kechika Group, Road River Group, Earn Group, sedimentary exhalatives, barite, lead, zinc.

INTRODUCTION

Cambrian to Mississippian rocks, deposited in a northwest trending depression called the Kechika Trough or Basin, are exposed along the western margin of the northern Rocky Mountains. The basin is host to numerous sedimentary exhalative barite-lead-zinc deposits of various ages, although the most numerous and economically important are Late Devonian, such as the Cirque (Stronsay) and Driftpile deposits.

The British Columbia Ministry of Energy, Mines and Petroleum Resources began a multi-disciplinary examination of this basin during the summer of 1994. This is a cooperative project with the Geological Survey of Canada and is funded, in part, by the second Mineral Development Agreement between the governments of British Columbia and Canada. This program included a detailed study of the Driftpile deposits (Nelson *et al.*, 1995, this volume; Paradis *et al.*, in press), a characterization of the geochemical signature of these occurrences (Lett and Jackaman, 1995, this volume) and a regional mapping project along the central part of the basin, north of Gataga River. This paper describes preliminary results of the regional mapping component.

The Gataga mapping project covers part of the western Muskwa Ranges of the northern Rocky Mountains, east and southeast of the confluence of the Gataga and Kechika rivers. The area is remote and primary access is by air (Figure 1). The centre of the map area is approximately 200 kilometres from both Dease Lake to the west and Watson Lake to the northwest. The larger communities of Mackenzie and Fort St. John are 400 kilometres to the southeast. The map area is bounded to the southwest by the Northern Rocky Mountain Trench, to the northeast by the Netson Creek - Netson Lake valley, by Forsberg Ridge to the southeast and by a northeast - trending line approximately 6 kilometres southwest of Gataga Mountain.

The southern third of the map area, between Gataga River and Forsberg Ridge, is characterized by subdued, glaciated terrain and the amount of exposure is less than 5%. Exposure increases dramatically northwest of the Gataga River with nearly 100% outcrop along ridges underlain by Cambrian carbonate rocks.

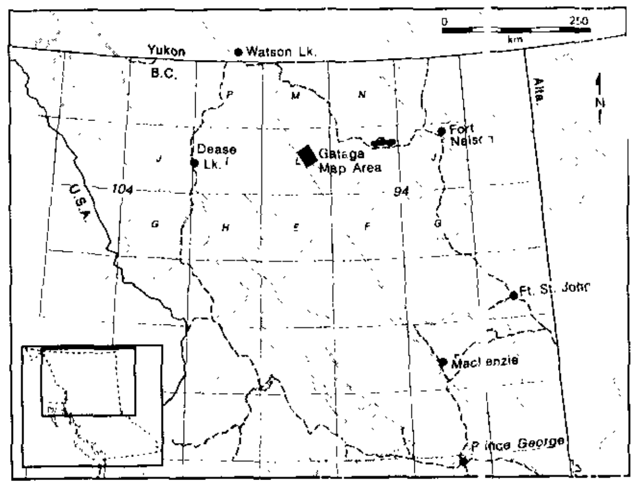

Figure 1. Northeastern British Columbia showing the location of the project area together with main physiographic and cultural features.

REGIONAL SETTING

The study area lies along the western margin of the Rocky Mountain subprovince of the Canadian Cordilleran Foreland Belt. The western boundary of the area follows the Northern Rocky Mountain Trench fault zone which separates displaced continental rocks of the Omineca Belt from ancestral North American strata of the Rocky Mountains (Figure 2). The Omineca Belt is represented by rocks of the Cassiar Terrane which bear similarities to those of the Northern Rocky Mountains although direct correlation is precluded by 450 to 750 kilometres of right-lateral displacement along the Northern Rocky Mountain Trench (Tempelman-Kluit, 1977; Gabrielse, 1985).

The Rocky Mountain subprovince is characterized by northeasterly folded and thrusted rocks of mainly Paleozoic and older strata (McMechan and Thompson, 1991). Strata within the map area range in age from Late Proterozoic to early Mississippian and record several depositional settings along the ancestral North American margin. The main depositional element in the map area is

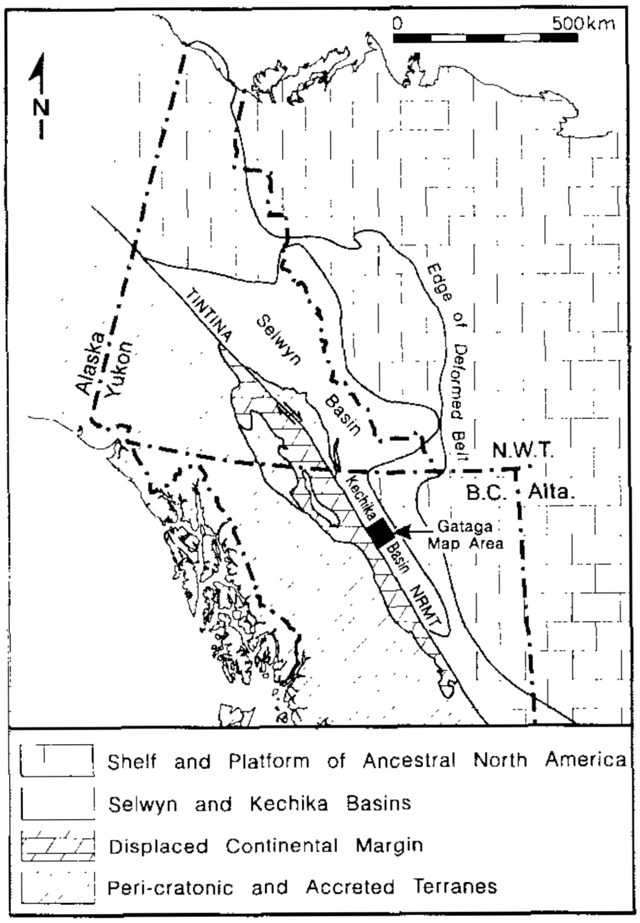

Figure 2. Simplified map of the northern part of the Canadian Cordillera showing the shelf-off-shelf boundary during Ordovician to Silurian time (modified from Cecile and Norford, 1991). NRMT - Northern Rocky Mountain Trench.

the northwest-trending, Paleozoic Kechika Basin which connects to the northwest with the Selwyn Basin in Yukon Territory (Figure 2). These basins are filled with finer grained, deeper water equivalents of coeval shelf and platform strata to the east. The geometry of the Kechika Basin is interpreted as either a westward-deepening basin (H. Gabrielse, personal communication, 1994) or as a narrow trough or embayment surrounded on three sides by shallower water facies (MacIntyre, 1992, McClay *et al.*, 1988). Rocks of the Kechika Basin were deposited on rift-related clastics of Late Proterozoic age which record the establishment of a passive continental margin by the end of the Precambrian. The basin was best developed during Ordovician to Devonian time when thick carbonate shelf sequences shaled out abruptly westward into off-shelf, fine-grained siliciclastic and carbonate rocks of the Road River Group (Cecile and Norford, 1979; Thompson, 1989). A much broader westward carbonate-to-shale transition is also present in Cambro-Ordovician strata of the Kechika Group (Cecile and Norford, 1979). Middle to Upper Cambrian carbonates also show a westward shale-out, although this transition is complicated by linear, north-trending reefal buildups in the western part of the basin (Fritz, 1979, 1980a, 1991; Gabrielse and Yorath, 1991). Similar carbonate buildups are found at the Middle Devonian level within the centre of the basin (Akie reefs; MacIntyre, 1992).

Fine-grained siliciclastics and minor limestone of the Upper Devonian Earn Group, and its eastern equivalent the Besa River Formation, represent a fundamental change in deposition across the western miogeocline. These rocks record the abrupt end of shallow-water carbonate deposition within the eastern miogeocline and the subsequent laying down of deeper water, fine-grained clastics. This widespread marine transgression has been attributed to rifting along the westernmost part of the miogeocline (Gordey *et al.*, 1987) or to contractional deformation (*i e.*, Antler orogeny; Smith *et al.*, 1993) with both models being supported by thick tongues of westerly derived coarse sediments in western Earn exposures.

Sedimentary exhalative barite±sulphide deposits of Middle Ordovician, Early Silurian and Late Devonian ages are present within the Kechika Basin (MacIntyre, 1992). The last are the most economically significant and are hosted by shales and siliceous shales of the lower Earn Group; the most important deposits are the Cirque (Stronsay), Driftpile Creek, Bear and Mount Alcock deposits. All are believed to have formed within sub-basins developed in response to either a Devono-Mississippian rifting event (Gordey *et al.,* 1987) or as a result of flexural extension related to westward foreland loading and deformation (Smith *et al.,* 1993).

PREVIOUS WORK

Reconnaissance - scale mapping along the northern part of Kechika Basin was first carried out by Gabrielse (1962a, b, and 1981), Gabrielse *et al.*, (1977) and Taylor (1979). Gabrielse examined the Kechika (94L), Rabbit River (94M) and Ware (94F, west half) areas, while Taylor mapped the Ware (94F, east half) and the Trutch (94G) map sheets. The southern parts of the basin have been mapped by Gabrielse (1975) in the Mesilinka River area (west half) and by Thompson (1989) in the Halfway River (94B) area. Taylor and Stott (1973) describe the shelf sequence immediately east of the study area.

More detailed regional mapping was conducted by MacIntyre (1980a, 1981a, b, 1982a) in the Akie River area and by McClay and Insley (1986) and McClay *et al.* (1987, 1988) between Driftpile Creek and Gataga River.

Early studies describing Ordovician and Silurian stratigraphy along the western part of the Kechika Basin include Jackson *et al.* (1965) and Norford *et al.* (1966). Taylor *et al.* (1979) elucidated the stratigraphy in the Ware (east half) map area. Fritz (1979, 1980a, 1991) details stratigraphic sections and relationships within Cambrian rocks of the Kechika Basin and the adjacent shelf sequence. Cecile and Norford (1979) describe the stratigraphic relationships along the transition between shelf and off-shelf facies in Ordovician and Silurian strata. Norford (1979) discusses Early Devonian graptolites within uppermost Road River strata between the Kwadacha and Akie rivers.

Published accounts of the economic potential of this area began in the early 1980s after nearly a decade of exploration within the Selwyn and Kechika basins. Early descriptions of the resource potential and exploration models for the Kechika Basin are provided by Carne and Cathro (1982) and MacIntyre (1982a, 1983). MacIntyre (1980b), Jefferson *et al.* (1983) and Pigage (1986) describe the geologic setting of the Cirque deposit. MacIntyre and Diakow (1982) give a brief account of the Kwadacha mineral occurrence and Irwin and Orchard (1989) refine the timing of mineralization in the Kechika and Selwyn basins.

STRATIGRAPHY

Rocks in the map area are preserved in a series of steep, southwest-dipping, northeasterly-verging thrust panels. Strata are represented by the Upper Proterozoic Hyland Group, the Lower Cambrian Gog Group, an unnamed Middle to Upper Cambrian sequence of carbonates and siliciclastics, the Upper Cambrian to Lower Ordovician Kechika Group, the Lower Ordovician to Lower Devonian Road River Group and the Middle Devonian to lower Mississippian Earn Group (Figures 3 and 4).

HYLAND GROUP (UPPER PROTEROZOIC)

Upper Proterozoic strata exposed in the map area are part of the Windermere Supergroup which forms a thick clastic wedge along the entire length of the Canadian Cordillera. These can be traced into similar Proterozoic rocks in the Nahanni map area which recently have been named the Hyland Group (Gabrielse and Campbell, 1991; Gordey and Anderson, 1993). The Hyland Group is subdivided into lower quartz-rich clastics of the Yusezyu Formation and overlying maroon to grey shales called the Narchilla Formation (Gordey and Anderson, 1993).

Rocks of probable Proterozoic age were observed in a handful of outcrops along the southwest slopes of the broad valley containing Netson Lake. These exposures consist predominantly of grey to green, greasy phyllite with minor thin-bedded, very fine grained sandstone. Lesser interlayered light to dark grey and cream-coloured slate, siltstone (calcareous) and very fine sandstone also occur. The predominantly phyllitic rocks outcrop immediately below Gog Group lithologies, suggesting they belong to the Narchilla Formation, whereas the grittier outcrops are stratigraphically lower than phyllites indicating they may be part of the Yusezyu Formation. The paucity of data does not allow differentiation between the two formations, all rocks of possible Proterozoic affinities are placed within undivided Hyland Group.

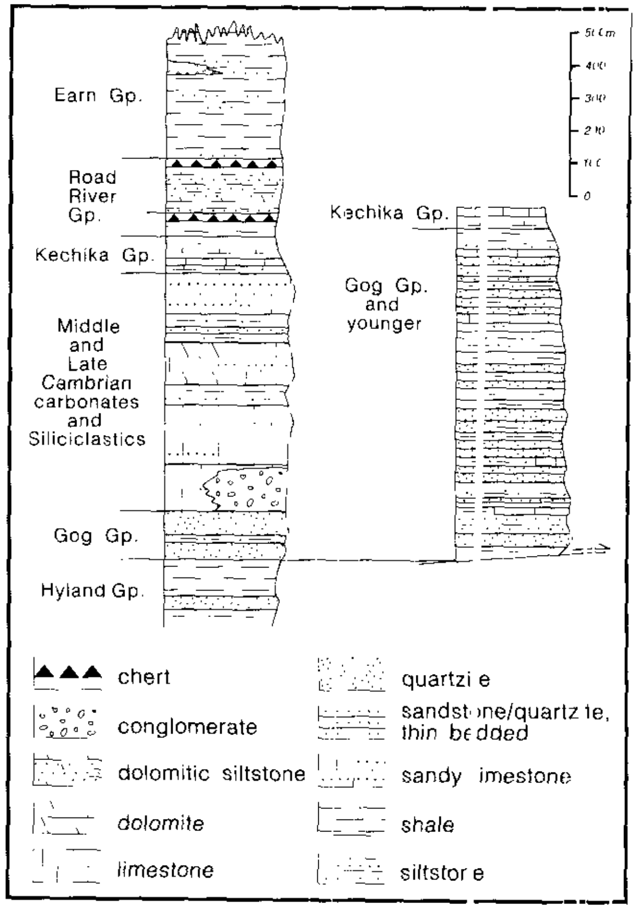

Figure 3. Simplified stratigraphic column of units within the project area. (a) Generalized column for the entire area. (b) Generalized column for the Gog and younger clastics found east and north of Split Top Mountain. See under *Gog and Younger Rocks*.

LOWER TO UPPER CAMBRIAN STRATA

Stratigraphically above the Hyland Group are thick sections of quartzose sandstone, siltstone, shale, carbonate and conglomerate of the Lower Cambrian Gog Group and an unnamed Middle to Upper Cambrian sequence of carbonate with lesser siliciclastics (Fritz, 1991). Rocks presently assigned to the Gog Group were previously called the Atan Group (Gabrielse *et al.*, 1977; Taylor and Stott, 1973) based on broad similarities between this quartzite-carbonate package and the type locality of the Lower Cambrian Atan Group in the Cassiar Mountains. The two-fold subdivision of Lower Cambrian strata, as exemplified by the Atan Group in the Cassiar Terrane, is not well developed in rocks of the Kechika Basin. The thick, Lower Cambrian carbonate is missing in the Gataga area. Instead, siliciclastics predominate with only thin

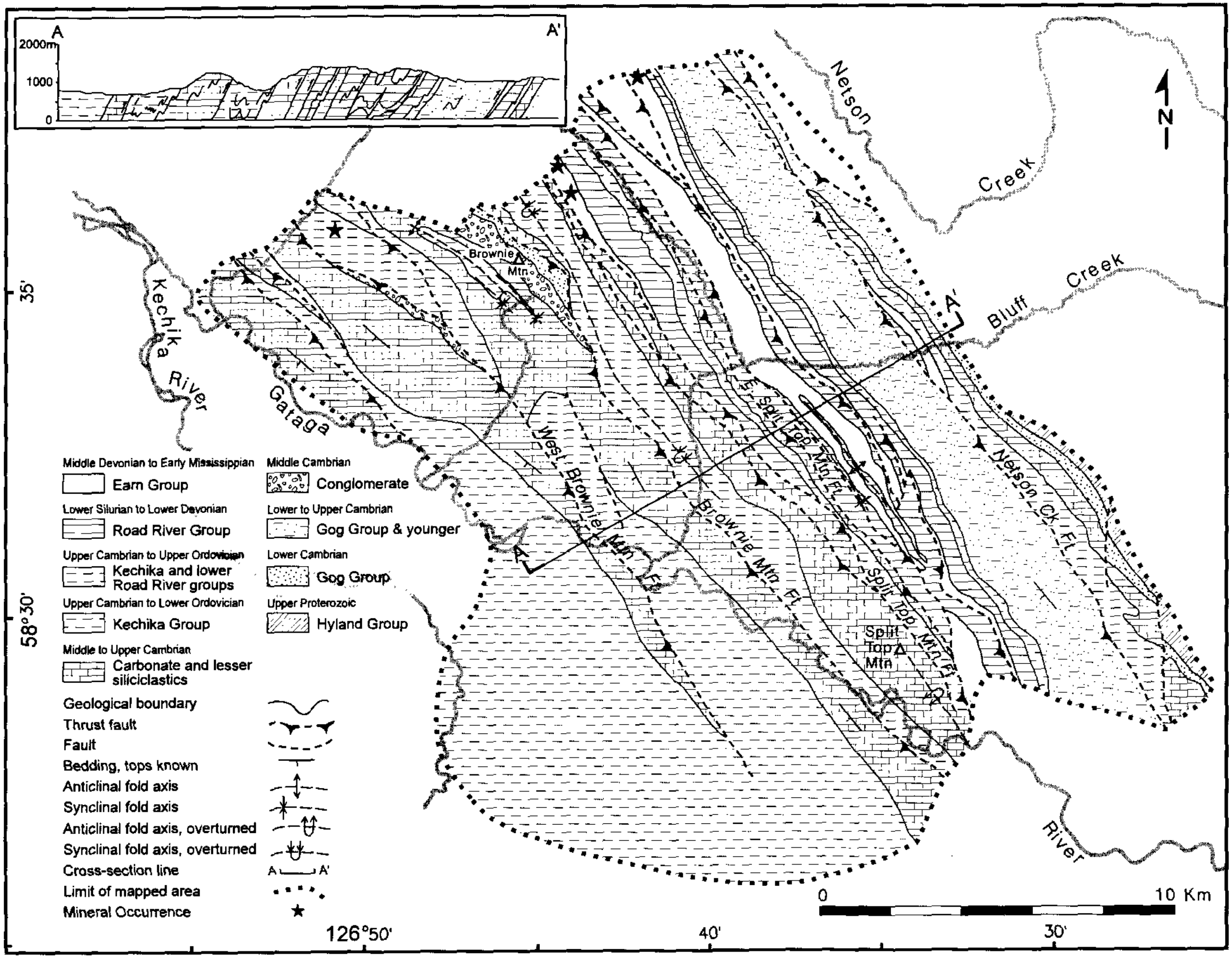

Figure 4. Generalized geological map of the study area. Inset shows stylized cross-section.

layers and lenses of archaeocyathid-bearing limestone. This led Fritz (1980b) to suggest that the term 'Atan Group' not be used east of the Northern Rocky Mountain Trench. The Lower Cambrian siliciclastic and lesser carbonate succession has broad similarities with the Gog Group as defined in the southern Canadian Cordillera, and that term is used here.

The top of the Gog Group is placed at the base of a thick carbonate succession which locally has been shown to be uppermost Lower Cambrian (Fritz, 1979, 1980a). In the map area, this carbonate succession, of mainly Middle and Late Cambrian age, shows rapid facies variations such that in some thrust panels carbonate is virtually absent. It is replaced by siliciclastic lithologies similar to the Gog Group, and which occur right up to the conformably overlying Kechika Group. This is particularly evident in the thrust panel east of Split Top Mountain where only a few metres of limestone and sandy limestone sit below Kechika Group rocks. Farther northwest, along strike, even these thin carbonates are missing. Similarly, in the far northeastern corner of the map area, the Cambrian carbonate south of Netson Lake passes northwestward into siliciclastics. The gradual northwestward disappearance of these thick Middle and Upper Cambrian carbonates is regionally significant. Nowhere north of Gataga Mountain do these carbonates reappear (Gabrielse 1962a, b).

Similar regional facies variations in Middle and Upper Cambrian successions have been documented elsewhere to the south and east (Gabrielse, 1981; Fritz, 1979; Taylor *et al.* 1979). These authors describe north to northwest-trending linear reefs separated by clastic facies. The rapid facies variations may reflect significant vertical fault motion resulting in the juxtaposition or interchange of shallow and deep-water environments. This theory is supported by the presence of thick uplift-related Middle Cambrian fanglomerates within the project area and to the east and southeast. These rocks grade laterally into typical Middle Cambrian lithologies (Taylor and Stott, 1973; Taylor *et al.*, 1979).

Where the Middle and Upper Cambrian carbonates are absent, Kechika Group rocks appear to rest conformably on top of slates and siltstones, which in turn lie conformably above coarser quartzose lithologies typical of the Gog Group. In the absence of a Middle Cambrian carbonate marker, it is not possible to precisely locate the top of the Lower Cambrian Gog Group within this thick succession. Assigning all these rocks to the Gog Group would be erroneous as, in its type locality it is restricted to the Lower Cambrian. Therefore, in areas where these dominantly siliciclastic Lower to Upper Cambrian rocks occur, we have assigned them to a composite unit designated *Gog Group and Younger Rocks*. Elsewhere, Cambrian rocks can be divided into Gog Group, the Middle Cambrian conglomerate unit, Middle and Upper Cambrian carbonates, and their siliciclastic equivalents, as follows.

GOG GROUP (LOWER CAMBRIAN)

As explained above, Gog Group rocks can be differentiated only in thrust panels containing thick Middle Cambrian carbonates. Poorly exposed sections of Gog siliciclastics and carbonates are exposed in thrust panels below the Netson Creek fault. In the far southeastern corner of the map area, thick to massively bedded, brown-weathering, brown to beige quartzite and quartz sandstone are found in sections up to 15 metres thick below the Middle Cambrian carbonate sequence. These quartzites and sandstones are sometimes calcareous and commonly show cross-stratification and bioturbation (*Cruziana)*.

A well exposed, but strongly folded and faulted sequence of Gog quartzites is exposed on the east face of Brownie Mountain. Here the unit comprises thick to massively bedded grey and brown impure quartzite, quartz sandstone and white quartzite with lesser grey siltstone and sandy siltstone. The exact thickness of this Gog section is difficult to determine as it is in the core of an overturned northeast-verging fold which is cut by a thrust fault. A rough estimate is in the order of 100 metres. Sections of quartzite to impure quartzite from 10 to 30 metres thick are separated by 10 to 20-metre sections of thin to thick-bedded quartz sandstone and siltstone. The massive to thick-bedded quartzite horizons show cross-stratification and rare bioturbation in the form of bedding-perpendicular *Skolithus* burrows. The thinner bedded sandstone and siltstone sections commonly contain current ripples and bedding-parallel worm burrows. Less common but conspicuous orange-weathering, cross-stratified limestone to sandy limestone which may contain thin interbeds of calcareous sandstone, is found in sections up to several metres thick.

GOG GROUP AND YOUNGER ROCKS (LOWER, MIDDLE AND UPPER CAMBRIAN)

The thickest and most continuous section of this unit is exposed along the eastern side of the map area, extending from the Gataga River to the northern map boundary. Structural sections indicate thicknesses of approximately 1200 metres in the north and 1500 metres in the south, assuming no thrust faults have repeated this rather monotonous package. The section consists predominantly of flaggy, thinly interlayered brown to beige fine-grained quartz sandstone, siltstone and grey-green to dark grey slate. Some sections are dominated by slate and siltstone and others by thin planar-bedded sandstone. Slate and siltstone sections commonly have a grey to dark grey striped or banded pattern and contain layer - parallel worm burrows or other trace fossils. The basal part of the sequence contains 10 to 30-metre sections of thick-bedded, tan to white quartzite interlayered with lesser, thin-bedded grey to brown siltstone and green to grey phyllite. Some of the thicker sandstone sections exhibit cross-stratification and wave ripples on bedding surfaces.

In the southern part of this panel of Cambrian clastics, approximately 50 to 150 metres of striped or uniform, grey, grey-blue to dark grey to black slate and siltstone is exposed at the top of the section, immediately below the Kechika Group. In the northern part of the panel, thin to moderately bedded, grey to orange-weathering grey limestone to sandy limestone, siltstone and black chert layers or nodules are present in the upper part of this package.

Although limestones form a minor part of this map unit, they are important. The lower half of the succession locally contains discontinuous layers or lenses of brown-grey weathering, grey fossiliferous limestone, 10 centimetres to over 2 metres thick. These limestone horizons contain abundant archaeocyathid remains which, together with their lensoidal shape, suggest biohermal buildups (Photo 1). As archaeocyathids in North America are restricted to the Lower Cambrian, at least this part of the succession is known to be equivalent to the Gog Group. In the upper half of the succession, two types of limestone are seen: a grey-weathering limestone breccia 1 to 5 metres thick, and a grey, buff to brown or tan-weathering interlayered limestone, sandy limestone to calcareous sandstone and quartzite sequence 1 to 50 metres thick. No archaeocyathids were observed in either of these higher limestones.

The limestone breccia is composed of subrounded and rounded clasts of oolitic and massive limestone, up to 5 centimetres in diameter, and lesser shale clasts in a sandy limestone matrix. Limestone breccia beds grade upward into laminar limestone overlain by calcareous sandstone and quartzite which rarely contain flute casts and scour marks when succeeded by another breccia horizon. These features suggests a debris-flow origin for these deposits.

The limestone and sandy limestone are moderately to thickly bedded with the latter exhibiting cross-stratification. Pure to sandy limestone (up to 30% quartz grains) may contain thin interlayers of quartz sandstone or quartzite, giving the rock a distinctive ribbed appearance. Carbonate breccia horizons as well as grey to green slate layers are present locally.

These carbonate facies are prevalent in the top part of the map unit, very near its upper contact, and it is possible that they are distal equivalents of the thick Middle and Upper Cambrian carbonates found in other thrust panels. This is supported by the local presence of carbonate debris - flows which may be derived from nearby coeval, thick carbonate buildups. The amount of carbonate in the upper part of this clastic panel decreases to the northwest which mimics the northwestward disappearance of the Middle to Upper Cambrian carbonates in other panels.

Clastic rocks of Early and probably Middle and Late Cambrian age are exposed along the northeast-facing slopes immediately south of Netson Lake. Grey and rusty weathering, greenish grey and silvery, banded micaceous slate and siltstone, together with thinly bedded, very fine grained quartz sandstone are found immediately northwest of the Middle to Upper Cambrian carbonate shale-out in the extreme northeastern part of the map area. This area definitely contains Gog Group equivalent rocks, evident from several archaeocyathid-rich limestone lenses within the slates and sandstones.

Photo 1. 10 - metre - long archaeocyathid - bearing bioherm (outlined in white) within Gog Group clastics located 5 kilometres east-northeast of Split Top Mountain. The isolated nature of these buildups is clearly illustrated by the enclosing thick sequence of shale, siltstones and fine sandstones. Scale is shown by geologist to the right of bioherm.

CONGLOMERATE (MIDDLE CAMBRIAN)

Up to 250 metres of distinctive massive, polymict granule to boulder conglomerate is exposed along the top of Brownie Mountain. It is brown weathering, brown to grey or green and occupies a stratigraphic position between the Gog Group and Middle Cambrian carbonates. Similar, but much thinner conglomerate is exposed in the hangingwall of the West Brownie Mountain thrust. The lower contact of this unit was not observed at Brownie Mountain but its top appears to

Photo 2. General view of Middle Cambrian fanglomerates along the ridge containing Brownie Mountain. Note the poorly developed bedding and the wide range in clast size.

grade upwards into the thick section of limestones and dolomites. The conglomerate is matrix supported with 30 to 70% subangular to rounded clasts. Clast types include brown to white quartzite (70%), orange, grey or maroon-weathering limestone (10%), dark grey, grey or green slate and siltstone (10%) and green basalt(?), diorite or gabbro (10%). Grey to brown slate, siltstone and sandstone horizons up to several metres thick are locally present (Photo 2).

This conglomerate bears remarkable similarities to a fanglomerate in a similar stratigraphic position in the Tuchodi Lakes and Ware map areas (Taylor and Stott, 1973; Taylor *et al.*, 1979). This is one of numerous Middle Cambrian facies and is known as the 'Roosevelt facies' due to its excellent exposure near Mount Roosevelt in the Tuchodi Lake map area (Fritz, 1991). This unit is up to 1500 metres thick and related to growth faults which exhumed Proterozoic strata (Taylor and Stott, 1973; Taylor *et al.*, 1979; Fritz, 1991). Similar amounts of uplift are inferred in the map area from the presence of green slate, siltstone, basalt and gabbro clasts which must have been derived from underlying Proterozoic units. Fritz (1979) collected early Middle Cambrian faunas near the base of this unit east of the map area and has placed it entirely within the Middle Cambrian.

CARBONATE (UPPERMOST LOWER TO UPPER CAMBRIAN)

Most of the spectacular peaks in the Gataga River area are composed of steeply dipping panels of thick-bedded limestone and dolomite (Photo 3). Excellent exposures are found along the ridge northeast of the Gataga River in the extreme southeast part of the map sheet. This carbonate can be traced to the northwest where it thins and finally disappears into shales and siltstones. Split Top Mountain represents the next westerly belt of this carbonate package. Several ridges of carbonate that trend northwest from this area delineate splays off the main thrust at the base of Split Top Mountain. These carbonates also thin northwestward and the last carbonate associated with this fault zone shales out at the northern edge of the map area. These carbonates are cut obliquely by the thrust at the base of Brownie Mountain. Impressive exposures of these rocks are also found on the ridge west of Brownie Mountain.

Thicknesses and lithologic character of these rocks change dramatically across the map sheet. Approximately 1500 metres of carbonate are inferred from structural sections through the rugged ridge west of Brownie Mountain, whereas only 600 metres of carbonate are exposed on the ridge along the southeastern boundary of

Photo 3. Looking southwest towards Split Top Mountain. This mountain is composed of Middle to Upper Cambrian carbonates which make up most of the other rugged peaks in the area. The Gataga River valley is immediately to the west and Forseberg Ridge is in the middle ground. The Northern Rocky Mountain Trench is between Forseberg Ridge and the high peaks in the distance.

the map area. The northward thinning and disappearance of these carbonates is illustrated by the section along the eastern boundary of the map area which progressively thins from an initial 700 metres.

The dominant lithology is massive to thickly bedded, grey to tan-weathering, grey to white micritic to finely recrystallized limestone. Thin, discontinuous horizons of more resistant, lighter coloured dolomite and dolomitic limestone are locally present. Carbonate breccia and conglomerate are less common but were mapped along the easternmost limestone body. Fenestral dolomite was also seen towards the base of this limestone panel. Large sections of this limestone sequence have been variably dolomitized, forming massive buff to orange-weathering sections in the Split Top Mountain area, at Brownie Mountain and along the ridge west of Brownie Mountain. Limestone or dolomite may contain up to 30% well-rounded quartz grains and may be interlayered with thin to thick beds or sections (up to 5 m thick) of white to tan-weathering quartzite which give the succession a distinctive ribbed appearance. Planar to cross-stratified quartzite and quartz sandstone become dominant toward the base of the carbonate panel northwest of the mouth of Bluff Creek. This section is characterized by rare, but distinct layers of quartz-pebble conglomerate 10 to 20 centimetres thick. Sandy dolomite stratigraphically near the top of these conglomerate horizons may contain isolated quartzite cobbles up to 5 centimetres in diameter.

Late Early, Middle and Late Cambrian faunas have been recovered from these thick packages of carbonate south and east of the map area (Fritz, 1979, 1980a). Fritz collected late Early Cambrian trilobites from the base of these carbonates south of the Gataga River.

SILICICLASTICS (MIDDLE TO UPPER CAMBRIAN)

Middle to Upper Cambrian siliciclastics and lesser carbonates form lenticular sequences between 30 and 350 metres thick, within the main carbonate succession. They consist of thin to moderately bedded, grey and brown to tan-weathering, grey siltstone, slate and quartz sandstone, interlayered with lesser grey to buff-weathering sandy limestone, sandy dolomite, dolomite and dark grey argillaceous limestone. Sandstone is wavy to planar bedded whereas siltstone and slate sections have colour banding or striping and frequently worm burrows on bedding planes. Several of these horizons are found within the limestone sequence in the southeastern part of the map area and northwest of Split Top Mountain, but are traceable for only a few kilometres.

These rocks are remarkably similar to finer clastics described under Gog Group and younger strata. These tongues of clastic material within the carbonate units reflect, on a smaller scale, the rapid facies variation within Middle and Upper Cambrian strata in the map area.

Photo 4. Basal Kechika Group slates, calcareous slates and interlayers of grey to orange - weathering limestone. These thin limestone beds are a distinctive feature of the lower Kechika Group within the map area.

KECHIKA GROUP (UPPER CAMBRIAN TO LOWER ORDOVICIAN)

The name Kechika Group was first used by Gabrielse (1963) in the Cassiar Mountains and was later used to describe Upper Cambrian to Upper Ordovician strata in the Trutch and Ware map areas by Jackson *et al.*, (1965) and in the Tuchodi map area by Taylor and Stott (1973). The present application of this name to argillaceous carbonates and shales of Late Cambrian to Early Ordovician age was first used by Gabrielse *et al.*, (1977) in the Ware map area.

The Kechika Group, as with the underlying Middle to Upper Cambrian sediments, shows considerable thickness and lithologic variation. Sections of Kechika Group are approximately 500 metres thick along the southeastern margin of the map area, but decrease northwestward along strike to less than 200 metres. A maximum of only 200 metres of Kechika rocks is found in the central part of the next thrust panel to the west where Middle and Upper Cambrian carbonates are missing. This thickness decreases to less than 50 metres northwestward along strike and the unit appears to be absent to the southeast. East of Split Top Mountain, Silurian rocks of the Road River Group are found less than 50 metres above Cambrian clastics with only black slates of possible Ordovician Road River affinity between the two. This suggests either removal of Kechika rocks by a pre-Road River unconformity as seen by Gabrielse (1981) in the Ware area or lateral transition into lithologies similar to the Road River Group. Rocks assigned to the Kechika Group farther west occupy the cores of tight, northeasterly overturned synclines and although thicknesses have been exaggerated tectonically, original sections must have approached 500 metres in thickness. The predominance of Kechika lithologies in areas of poor exposure between massifs of Middle to Upper Cambrian carbonate south of the Gataga River suggests thicknesses of this magnitude or greater.

In the eastern part of the map area, the basal part of the Kechika Group comprises grey to dark grey, cleaved slate and silty slate, with discontinuous beds and lenses of grey and orange-weathering limestone to calcareous slate up to 10 centimetres thick that constitute up to 30% of the section (Photo 4). Generally, the thickness and percentage of limestone decreases up-section and only slate is present at the upper contact. Locally, grey to orange-weathering, planar-laminated dolomitic siltstone and silty slate up to 10 metres thick are found above Cambrian limestone. Light to medium grey weathering, dark grey micritic limestone up to 1 metre in thickness is locally found in the upper part of the Kechika Group along the northeastern edge of the project area. Upwards of 20 metres of orange-weathering, cleaved, bioturbated dolomitic slate to silty slate is present in the upper part of the Kechika Group east and northeast of Split Top Mountain. Generally, the carbonate content decreases northward in eastern exposures of the Kechika Group.

Green slate up to 5 metres thick, with distinctive crystals of barite up to 1 centimetre long, is found at the base of the Kechika Group, above Cambrian siliciclastics east of Split Top Mountain. Barite crystals were also observed in basal calcareous horizons of the Kechika Group in the northernmost part of this thrust panel.

Grey, buff and orange-weathering, grey and silvery slate, calcareous slate and silty slate with lesser thin beds or lenses of grey limestone characterize most of the Kechika Group immediately east and southwest of Brownie Mountain, and south of the Gataga River. Typically the carbonate content decreases up-section. Thin interlayers of grey limestone, from 0.5 to 10 centimetres thick, are abundant in the lower 50 metres. The Kechika Group is lighter coloured and more calcareous south and southwest of the Gataga River. In this area Kechika slate has characteristic light and dark grey colour laminations resulting from increased silt and/or carbonate content within lighter coloured horizons. This feature is very useful in differentiating these rocks from similar dark slates of the Road River Group, however, in some places Kechika slate is also dark in colour. This creates mapping problems in that the boundary between the two units is obscure, and the local absence of Kechika rocks is easy to overlook.

The Kechika Group rests unconformably above Cambrian carbonates in several localities. In the southeastern part of the map area, basal Kechika slates contain blocks of the underlying Cambrian carbonate. Similar relationships are seen at the eastern base of Brownie Mountain where carbonate clasts are found in Kechika slates at their contact with Middle to Upper Cambrian carbonates. West of Brownie Mountain various lithologies of the underlying Cambrian succession (carbonate, siliciclastics) are found below the Kechika Group, again suggesting an unconformable relationship.

This relationship is equivocal where the thick Middle and Upper Cambrian carbonates are lacking in the panel east of Split Top Mountain. The first orange-weathering limestone beds of the Kechika Group sit above approximately 25 metres of dark grey to black slate which grades downward into Cambrian siliciclastics east of Split Top Mountain. These dark slates appear similar to those interlayered with the overlying orange and grey limestones of the Kechika Group. There may be an unconformity between the similar shales, but it is impossible to distinguish. In the northeastern part of the map area Middle or Upper Cambrian limestones appear to be interlayered with Kechika slates near where these carbonates shale out. Limestone beds up to 1 metre thick and of similar appearance to the Cambrian carbonates are found at the base of the Kechika Group at this locality.

Graptolite collections from the Kechika Group have returned Early Ordovician ages. These are consistent with the highest beds of the group being Arenigian (late Early Ordovician; B.S. Norford, personal communication, 1994).

ROAD RIVER GROUP (LOWER ORDOVICIAN TO LOWER DEVONIAN)

The name Road River Group was extended into the Northern Rocky Mountains from its type locality in the Yukon by Gabrielse *et al.*, (1977). It is divided into two unnamed formations; an Ordovician sequence of black graptolitic slate and chert, and Silurian to Lower Devonian siltstone, graptolitic slate and minor chert.

BLACK SLATE/CHERT (LOWER TO UPPER ORDOVICIAN)

Complete sections of Ordovician Road River strata are confined to the eastern part of the project area. Approximately 125 metres of this unit is exposed along the banks of a creek in the southeastern part of the map area, below the thrust carrying the thick package of Cambrian siliciclastics. Upwards of 160 metres of Ordovician black slates are reasonably well exposed in the southern part of the next major thrust panel to the west. This sequence thins to 115 metres immediately south of Bluff Creek and only 50 metres are well exposed on the ridge to the north of the creek. Poor exposures farther north along this thrust panel suggest a thickness of only 50 metres.

Road River black slates crop out within the core of the northeast-verging syncline east of Brownie Mountain. A thick section of these rocks is also exposed west of Brownie Mountain and appears to rest directly on Cambrian clastics and carbonates. Assignment of black slates to either the basal Road River Group or Kechika Group becomes problematic in the Brownie Mountain area and in other areas to the east. Differentiating between the two units is virtually impossible in some localities and they have been grouped together. The difficulty in separating the two units may reflect a facies transition whereby Kechika rocks become more shaly and appear similar to the basal Road River strata. Furthermore, it is sometimes extremely difficult to differentiate between slates of the basal Road River Group and those of the Earn Group, especially where intervening, stratigraphically younger Road River rocks are poorly exposed. Biserial graptolites, which are restricted to the Road River slates, are helpful in resolving this problem.

Photo 5. View to the northwest showing resistive Road River Group dolomitic siltstones showing a thrust fault (arrow) with small displacement. Gataga Mountain is highest snow capped peak in the distance with Brownie Mountain immediately to the left. Although these rocks are quite argillaceous, they form resistive ridges due to their location between less competent lithologies of the Kechika and Earn groups.

The basal part of the Road River Group is composed of graptolitic dark grey, blue-grey and black graphitic slate and siliceous slate. Grey - brown and orange-weathering siltstone, up to 2 metres thick, and thin, grey, tan to orange-weathering, thin planar-laminated limestone beds are less common lithologies within this slate succession. Resistant layers of dark grey to black graphitic chert and siliceous argillite, 1 to 5 - centimetres thick, are found interlayered with the slaty rocks in the upper 5 to 10 metres of this unit.

Pale grey to greenish baritic tuff up to a metre thick is traceable for over 1.5 kilometres northwest of Brownie Mountain. A thin 'greenstone' horizon has also been mapped within basal Road River rocks near Gataga Mountain (B.S. Norford, personal communication, 1994). Volcanic rocks are reported elsewhere near the base of the Road River Group and are referred to as the Ospika volcanics (MacIntyre, 1992; Gabrielse, 1981). Thick volcanics underlying Gataga Mountain immediately to the north were originally believed to be Devono-Mississippian but are now thought to be part of this suite (H. Gabrielse, personal communication, 1994).

Graptolites recovered near the base of the Road River Group north of Bluff Creek are Middle Ordovician (Caradoc). Elsewhere the range of the basal Road River Group has been shown to be Early to Late Ordovician (Cecile and Norford, 1979).

SILTSTONE/SLATE (LOWER SILURIAN TO LOWER DEVONIAN)

Resistant, buff-orange weathering, grey to greenish grey, bioturbated dolomitic siltstone is the dominant member of the upper Road River Group (Photo 5). This unit is commonly referred to as the 'Silurian siltstone', although McClay *et al.* (1988) recovered Early Devonian conodonts from it. Bedding is difficult to discern in bioturbated sections except in thick - bedded shale and siltstone intervals. The rocks are thinly layered and planar laminated where bioturbation is lacking; and have a distinctive flaggy parting. Monoserial graptolites are typically preserved within these flaggy, non-bioturbated successions. Slates of the basal Road River are gradational with overlying Silurian siltstones over an interval ranging to tens of metres. The basal part of the Silurian siltstone may contain sections of grey, nondescript slate and silty slate more than 100 metres thick. Grey slates and siltstones in the footwall of the Split Top Mountain thrust fault have been assigned to the upper Road River Group as they are on strike with typical Road River lithologies farther to the northwest. Thin-bedded orange-weathering planar-laminated, flaggy limestone to silty limestone is locally developed.

The upper 10 to 15 metres of the Road River Group contains a distinctive chert-limestone succession which is locally an excellent marker (Photo 6). Dark grey-brown, grey and white, thin to thickly bedded chert with interlayers of dark grey cherty argillite comprises the basal 2 to 3 metres of this sequence. Approximately 1 to 2 metres of thin to moderately bedded, cream to light grey weathering, grey, silty to argillaceous micritic limestone interlayered with thin beds of typical Silurian siltstone are exposed 1 to 2 metres above the chert sequence. Several metres of orange-weathering, bioturbated siltstone succeed this limestone sequence and grade into overlying

Photo 6. View of the uppermost Road River Group showing the chert-limestone unit. Grey to brown chert can be seen beneath the hammer and this is followed by thinly interlayered limestone. Earn Group lithologies begin a few metres to the right of the photograph.

lithologies of the Earn Group across a stratigraphic thickness of 50 centimetres.

This chert-limestone couplet is recognized only along the well exposed ridges east of the Split Top Mountain thrust. Poor exposure may limit its expression elsewhere in the map area.

The main belt of upper Road River rocks is a thrusted and folded sequence east of the Split Top Mountain thrust and west of the thick package of Cambrian clastics. Silurian siltstone is also recognized in several thrust panels in the northeastern part of the map area and in the core of the northeasterly overturned syncline east of Brownie Mountain. Structural thicknesses are quite variable, ranging from 200 to 300 metres in the southern part of the main outcrop belt to 400 metres in the centre and approximately 250 metres in the northern part. Thicknesses ranging from 550 to 700 metres were deduced for the poorly exposed section east of Brownie Mountain. Stratigraphic thicknesses for the Siluro-Devonian part of the Road River immediately southwest of the map area are in the order of 75 to 200 metres (Gabrielse, 1981; McClay *et al.*, 1988) whereas 250 to 600 metres of this unit are reported near the edge of the Kechika Basin in the Ware and Trutch map areas (Cecile and Norford, 1979; Gabrielse, 1981). These sections suggest that the greater thicknesses of Siluro-Devonian Road River calculated within the present map area, especially in the poorly exposed regions, have resulted from structural thickening.

Only one macrofossil collection was recovered from the upper Road River within the map area during the 1994 field season. Lower Silurian (Wenlock to possibly late Llandovery) monograptids were collected from the lower part of the siltstone section east of Split Top Mountain. These graptolites occur close to the Cambrian contact with little or no Kechika or basal Road River below. Elsewhere, the orange-weathering dolomitic siltstone package has been shown to be Silurian (Cecile and Norford, 1979; Gabrielse, 1981). McClay *et al.* (1988) recovered Lower Devonian conodonts from limestones within the siltstone sequence. The chert-limestone sequence is very similar to Upper Silurian to Lower Devonian chert and limestone at the top of the Silurian siltstone in the Akie River area (MacIntyre, 1992). Lower Devonian basinal lithologies are up to 200 metres thick in the Akie River area near the edge of the paleocontinental shelf, but thin markedly to the west, within the basin (MacIntyre, 1992; Norford, 1979; Gabrielse, 1975).

EARN GROUP (MIDDLE DEVONIAN TO LOWER MISSISSIPPIAN)

Black slate, siltstone, chert and sandstone of late Middle Devonian to early Mississippian age in the map area belong to the Earn Group. The name Earn Group was extended southward from its type locality in the Yukon by early workers in the Gataga district who noted the striking similarity between Devono-Mississippian strata of the Kechika and Selwyn basins (Jefferson *et al.*, 1983; Pigage, 1986; MacIntyre, 1992; Gordey *et al.*, 1982).

The Earn Group has been subdivided into three informal units in the southern Kechika Basin; blue-grey weathering siliceous argillite of the Middle to Upper Devonian Gunsteel formation; rusty weathering, soft grey shale of the Akie formation; which grades laterally into chert-quartz siltstone, sandstone and conglomerate of the Warneford formation (MacIntyre, 1992; Pigage, 1986; Jefferson *et al.*, 1983). Although these three lithological variations of the Earn Group were recognized in the map area, it was not possible to map out the individual facies. This was due not only to the poor exposure of this succession, but also to the apparent interfingering of the various lithologies.

A structurally thickened section of Earn and Road River rocks extends from the Gataga River, immediately east of Split Top Mountain, northwestward to the north edge of the map sheet. The unit is well exposed along ridges in the southern part of this belt, whereas to the north topography becomes more subdued and the best exposures are found in creek valleys. Another important panel of Earn rocks is an apparently northwestward-thickening wedge in the footwall of a thrust carrying Middle Cambrian carbonates northeast of Brownie Mountain. Smaller occurrences of the Earn Group are mapped along the lower parts of Bluff Creek, on the northeast-facing slopes immediately south of Netson Lake and as isolated occurrences in the low ground east of the Kechika River. A minimum of 600 metres of this unit is inferred along poorly exposed slopes in the northern part of the map area as no upper contact is present.

The Earn Group is composed of grey to blue or silvery blue-grey weathering, dark grey to black, carbonaceous fissile shale, slate to siliceous shale. Sequences of blocky grey to dark grey sooty argillite to siltstone, siliceous argillite or chert are found within this shaly succession. Blocky argillaceous to silty sections contain 1 to 10-centimetre beds with thin interlayers of shale and display light to dark grey colour banding higher in the sequence. Less siliceous shale or slate sections can be recessive and appear to be present throughout the sequence. Sections of grey to dark grey to rusty weathering sooty slate with lustrous cleavage planes crop out along the middle part of Bluff Creek.

One of the characteristic features of the Earn Group in the Gataga district is the presence of red to orange limonitic seeps which locally cement glacial and soil material forming a ferricrete deposit or pavement. These deposits are numerous and easily seen from the air in the high alpine country south of the map area, but are more difficult to locate in the more subdued and wooded terrain covered by our mapping. Several are well exposed on the south side of Bluff Creek and numerous other occurrences were found in creek valleys and slopes underlain by the Earn Group.

Limestone, although rare in this fine clastic sequence, forms conspicuous sections when present. Grey, fine to coarsely recrystallized limestone with local barite replacement is found as isolated layers from 10 to 50 centimetres thick. A 2 to 3-metre section of grey-weathering, grey to dark grey, slightly argillaceous limestone with 1 to 10-centimetre argillaceous partings is exposed several kilometres north of Bluff Creek.

Dark grey to rusty weathering, dark grey, granule to pebble - conglomerate was noted in one locality towards the top of the Earn succession south of Bluff Creek. Clasts consists predominantly of subrounded to well rounded, light to dark grey chert and mono- to polycrystalline quartz with lesser sandstone, quartz wacke, slate, siltstone and feldspar fragments. This bed is 1.5 metres thick and approximately 15 metres long. Coarse to fine clastics of similar composition are quite common in the upper and western parts of the Earn Group. Regionally, these clastics contain paleoflow indicators giving westerly to northerly source areas (Gordey *et al.*, 1991).

The basal part of the Earn is dominated by shale, siliceous shale and slate which regionally hosts significant deposits of bedded barite±pyrite±sphalerite±galena. Several occurrences of stratiform or nodular barite and pyrite were encountered within the lower part of the Earn Group within the project area.

STRUCTURE

The structural fabric of the map area is controlled by northeasterly directed thrust faults. The thrust sheets are internally folded, have moderate to steep southwest dips and contain a pervasive, penetrative cleavage within argillaceous lithologies. Cambrian clastics and carbonates form the most competent stratigraphic sequence and tend to form rigid thrust panels (Photo 7). Kechika and Ordovician Road River shales comprise the most important zone of detachment in the map area. This is primarily the result of the low structural competency of these lithologies and their location between more rigid siltstones of the Road River Group (Photo 5) and carbonates and quartzitic rocks of the Cambrian succession. Earn lithologies are also relatively incompetent.

Major thrust faults in the map area carry Cambrian or uppermost Proterozoic strata in their immediate hangingwall (Photo 7). Five large thrust sheets have been delineated and the bounding thrust faults are informally referred to (from west to east) as: West Brownie Mountain, Brownie Mountain, Split Top Mountain, East Split Top Mountain and Netson Creek faults (Figure 4). These subdivisions roughly correspond to the four thrust packages mapped by McClay *et al.* (1988) to the southwest.

Displacement on these major thrusts is substantially larger than on individual thrust faults found higher in the stratigraphy of each thrust sheet. Some of the displacement on the larger faults must have been transferred into a series of smaller scale thrusts and associated folds in their footwalls. This is well displayed below Split Top Mountain and East Split Top Mountain thrust faults where Earn and Road River strata are repeated by small-scale folding and faulting. Thrusts within Earn and Road River rocks probably extended downward into the Kechika Group and this displacement must feed into the larger thrusts carrying Cambrian

Photo 7. View to the southeast from Brownie Mountain. Split Top Mountain is the isolated peak at the right of the skyline. Several thrust slices of Middle to Upper Cambrian carbonate can be seen in this photograph and have been outlined. These extend northwestward from Split Top Mountain and continue past the northern limit of the project area.

stratigraphy. McClay *et al.* (1988) have demonstrated similar features to the south which are part of duplex structures between major thrust faults.

Very large, northeasterly overturned folds can be recognized in the map area. The best example is the large syncline immediately east of Brownie Mountain. To the west of this is an anticline which has been cut by the Brownie Mountain fault (Photo 8). The thick Middle to Upper Cambrian carbonate successions commonly delineate northeasterly overturned anticlines at the leading edge of thrust panels. Excellent examples of this are along the southwest side of Split Top Mountain and on the carbonate knoll east-northeast of Brownie Mountain (Photo 9). Smaller scale folds with nearly horizontal axial planes are exposed on the west flank of Split Top Mountain . These folds were probably formed quite early in the deformation history and were then rotated into their present position by movement on the Split Top Mountain thrust. Apparently thick sections of Kechika and Ordovician shales in the south and southwestern part of the map area are probably the result of tectonic thickening within the cores of these larger scale folds.

The near linear nature of the lower Gataga River suggests it is a major fault. The relationship of this apparent structure to the right-lateral Northern Rocky Mountain Trench fault further suggests that it is a splay of this large structure with the same relative motion. Mapping of thick Middle and Upper Cambrian carbonate units across the Gataga River does not indicate any substantial fault displacement along the river. Right-lateral displacements of up to 200 metres can be inferred along the lower part of the Gataga River by the extrapolation of carbonate units across it. This implied displacement is difficult to substantiate considering the scale of mapping and lack of outcrop along the south side of the river.

ECONOMIC GEOLOGY

The highest potential for economic mineral deposits within the map area occurs in Devonian rocks of the Earn Group. This unit is known to host numerous economically significant sedimentary exhalative barite-sulphide deposits elsewhere in the Kechika and Selwyn basins. Barite-sulphide mineralization found within the lower part of the Earn Group over the course of the 1994 field season reflects this high mineral potential and suggests the possibility for other occurrences. Barite mineralization was also discovered in Ordovician shales of the Road River Group and basal rocks of the Kechika Group. Although no Silurian mineralization is known in the map area, the presence of barite and barite-sulphide occurrences in Ware and Trutch map areas (Cecile and Norford, 1979; MacIntyre, 1992), together with the enormous Early Silurian Howards Pass deposit of the Selwyn Basin, suggests that the potential of Silurian rocks should not be overlooked. Anomalous nickel-zinc values in some areas underlain by Earn rocks suggest the possible presence of stratiform nickel-zinc-platinum

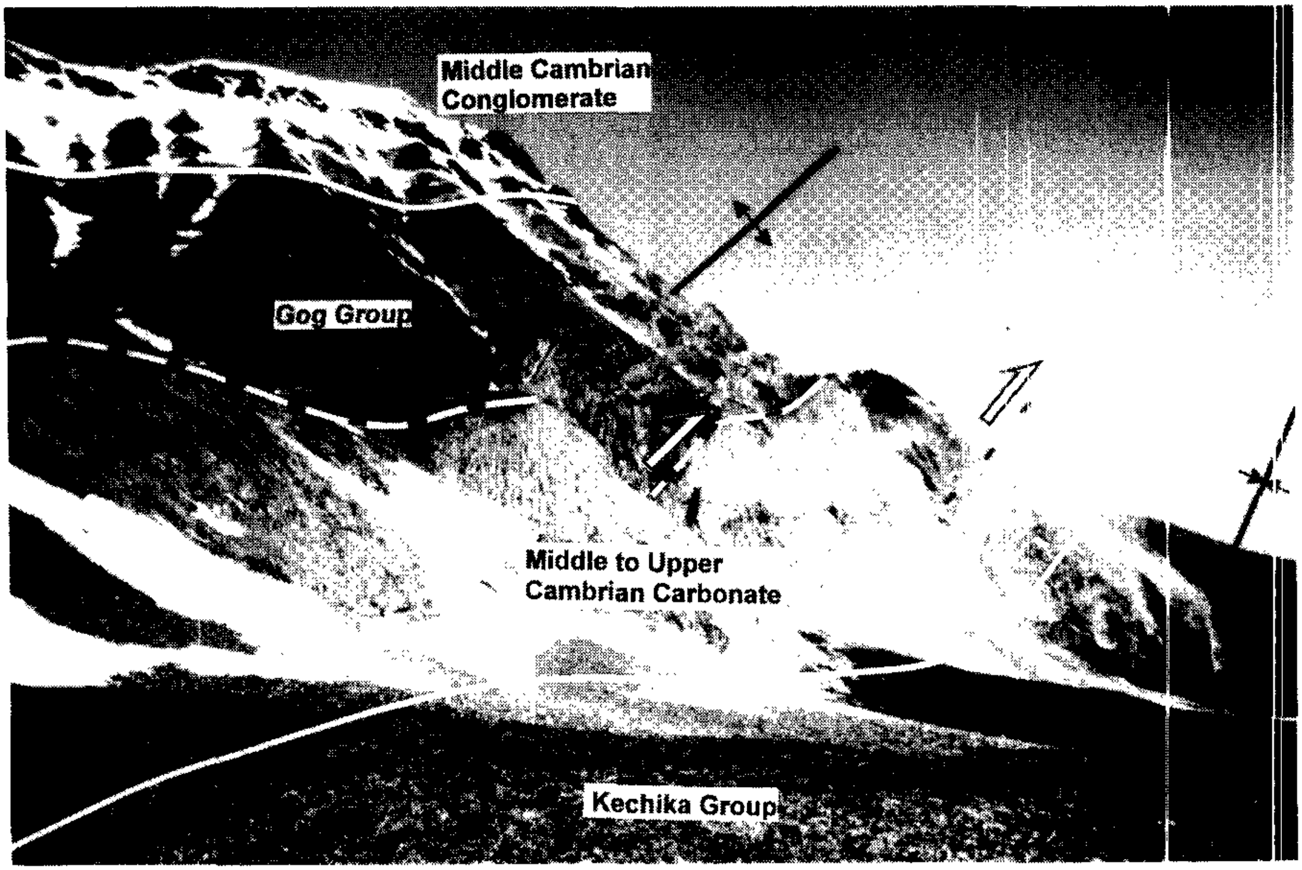

Photo 8. Scene along the east face of Brownie Mountain showing overturned rocks of the Kechika Group and Middle to Upper Cambrian carbonates. These are on the west limb of a northeasterly overturned syncline. Thrust above these are Gog Group siliciclastics within the core of a northeast - verging anticline, and Middle Cambrian conglomerate along the top of the ridge.

group element (PGE) deposits similar to those in the Selwyn Basin (Carne and Parry, 1990; Carne 1991). Several sulphide-bearing veins were also found in Middle Cambrian and Earn rocks. The following section gives a brief account of each occurrence within the map area. A detailed description of the deposit types is beyond the scope of this paper and the reader is referred to MacIntyre (1992) for a synopsis of Devonian and older mineralization within the Gataga district, and to Paradis *et al.* (in press) and Nelson *et al.* (1995, this volume) for a detailed account of the Driftpile Creek occurrence. Nickel-zinc-PGE mineralization is characterized by Hulbert *et al.* (1992) in its type locality in the Selwyn Basin.

STRATIFORM MINERALIZATION

EARN GROUP

The belt of Earn Group exposed within the map area is a northwestward continuation of the structural panel outlined by McClay *et al.* (1988) to the southeast which contains the Driftpile Creek, Bear and Saint deposits. Stratiform barite and barite-sulphide mineralization has been traced intermittently for a strike length of nearly 50 kilometres in this panel. It is theorized that the individual mineral deposits in this southern belt resulted from ponding of mineralized fluids within local sub-basins located along a larger basin containing widespread, more diffuse mineralization. Mineralized horizons within this same belt of rocks in the map area suggest that this large-scale metallotect continues to the north and thus has the potential to contain more, strongly mineralized sub-basins (MacIntyre, 1992; Carne and Cathro, 1982; McClay *et al.* 1988).

Barite±Sulphides

Three occurrences of barite-pyrite mineralization were seen within the lower Earn Group in the northern part of the map area during the 1994 field season. The most easterly of these is 25 metres stratigraphically above the base of the Earn and is hosted by grey to rusty weathering, dark grey to black carbonaceous shale to siliceous shale and chert. The baritic horizon is approximately 1 metre thick and contains up to 30% slightly ovoid barite nodules from 0.1 to 0.5 centimetre long. Slaty cleavage is deflected or refracted around the nodules. These are associated with pyritic horizons composed of either coarse authogenic pyrite or, more

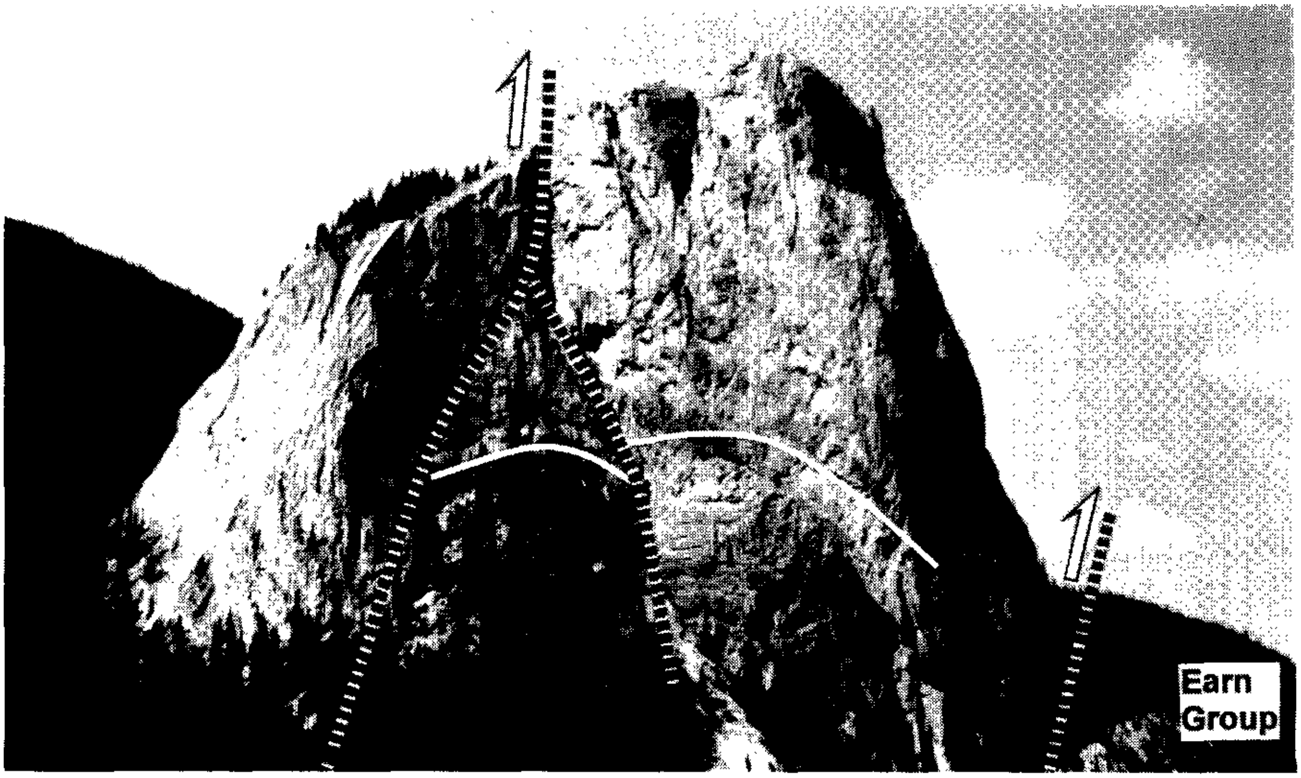

Photo 9. Looking north at a carbonate knoll approximately 2.5 kilometres north of Brownie Mountain. These Cambrian carbonates are thrust above Earn Group lithologies. This scene illustrates the common presence of northeast - verging folds along the leading edge of thrust panels carrying thick Cambrian carbonates. This fold has also been complicated by subsequent faulting. Bedding is high lighted with white lines.

importantly, thin layers of very finely crystalline pyrite. Pyritic, light coloured cherty lenses are also found along this horizon. This mineralization is similar to 'blebby' barite and exhalative pyrite horizons seen at the Driftpile Creek deposit.

The other two occurrences are within a panel of Earn rocks immediately east of Brownie Mountain. The more southerly showing is poorly exposed towards the base of the Earn Group and consists of 10 to 30 centimetres of light grey, slightly banded baritic slate with 1 to 3% disseminated pyrite. Lenses of darker slate are also found along this horizon. Surrounding lithologies consist of rusty and blue-grey weathering dark grey and black carbonaceous and blocky shale and siliceous shale.

Earn Group rocks are well exposed along a creek approximately 1 kilometre northwest of this second occurrence and consist of grey and rusty weathering, dark grey and black carbonaceous and siliceous shale, slate and siltstone. Isolated horizons of nodular barite were observed together with thin layers of finely crystalline pyrite. A limonitic seep is located immediately below this outcrop.

This belt of Earn rocks within, and immediately to the north of the map area, has been shown to contain zones of anomalous zinc concentrations (Boyle, 1978a, b; Stewart, 1980; MacArthur, 1982; Carne and Parry, 1990; Carne, 1991). Numerous limonitic seeps, ferricrete and calcrete occurrences are found within Earn rocks and contain anomalous zinc values. Many of these anomalous zones are situated along and to the south of Bluff Creek. Interest in these deposits waned due to the lack of a corresponding lead anomaly.

Nickel-Zinc-Platinum Group Elements

Re-evaluation of Earn lithologies with anomalous zinc values in the area around Bluff Creek resulted in the delineation of corresponding nickel anomalies which led Carne and Parry (1990) and Carne (1991) to suggest that these reflect stratiform nickel-zinc-PGE mineralization similar to the Nick property in the Selwyn Basin. The mineralized horizon in the Yukon is very thin (approximately 3 cm) but contains average nickel and zinc concentrations of 5.3% and 0.73%, respectively (Hulbert *et al.*, 1992). It is located at the base of the Earn Group, near its contact with the Road River Group, and is laterally extensive. Stratigraphic sequences similar to that hosting the Nick deposit (limestone ball member and succeeding phosphatic chert, see Hulbert *et al.*, 1992) were not observed in the map area, although this may reflect the relative thinness of the sequence and the relatively poor exposure of this horizon.

The present interest in this deposit is more academic than economic. The very thin nature of this deposit in the Yukon (3 centimetres) would presently not allow the economic retrieval of the nickel, zinc and corresponding PG elements.

ROAD RIVER GROUP

Greenish grey and tan siliceous and baritic tuff or tuffaceous siltstone, approximately 1 metre thick, are interbedded with Ordovician black slates of the Road River Group 4 kilometres west of Brownie Mountain. Internally this unit contains barite, pyrite and slate-rich laminations. It is exposed in three creek canyons, giving it a strike length of at least 1.5 kilometres.

Barite±sulphide mineralization of Middle to Late Ordovician age is documented from the southern part of the Kechika Basin (MacIntyre, 1992; Cecile and Norford, 1979). The Akie-Sika occurrence is a barite unit 1 metre thick, within Middle Ordovician shales, which MacIntyre (1992) believes is genetically related to coeval volcanism in the basin. This assumption is supported by the tuffaceous character of this horizon in the map area, assuming these tuffs are related to the volcanism in the southern Kechika Basin. Cecile and Norford (1979) report baritic horizons in Late Ordovician shales of the Road River Group close to the shelf edge.

KECHIKA GROUP

Green, possibly tuffaceous slate, up to 5 metres thick, is exposed at the base of the Kechika Group east of Split Top Mountain. Similar slate, although calcareous, crops out within Kechika rocks in the northeastern part of the map area. This unit is also characterized by 1 to 3-centimetre beds containing authogenic barite crystals up to 1 centimetre in size and locally comprising up to 30% of the layer. These crystals must reflect elevated barium levels during deposition. Cecile and Norford (1979) have reported scattered crystalline nodules from the base of the Kechika Group in the Ware and Trutch map areas. These occurrences suggest that some form of mineralization, possibly related to volcanism, was associated with the initiation of Kechika deposition.

VEINS

Several occurrences of vein mineralization were encountered within the map area. The first, carrying copper, occurs near the top of a steeply southwest-dipping Middle to Upper Cambrian limestone, south of Bluff Creek. Anastomosing quartz veins have a composite thickness of 3 to 4 metres; individual veins are up to 1 metre thick. The veins are approximately concordant with bedding. Lenses or sheets of limestone between the veins commonly contain strongly silicified rock which may have been siliciclastic interbeds in the host limestone.

Chalcopyrite and chalcocite were noted along several parts of the vein system. Weathered fracture surfaces in the quartz veins are coated with orange to red-brown iron oxides, and locally with extensive malachite and azurite.

The second occurrence of minor vein mineralization consists of thin tetrahedrite and barite-bearing quartz-calcite veins within the Earn Group in the northeastern part of the map area. These veins are only centimetres thick, discontinuous and contain only traces of malachite.

CONCLUSIONS

- Mapping in the project area has delineated several large thrust panels containing rocks of the Upper Proterozoic Hyland Group, Lower Cambrian Gog Group, Middle to Upper Cambrian carbonates and siliciclastics, Upper Cambrian to Lower Ordovician Kechika Group, Lower Ordovician to Lower Devonian Road River Group and Middle Devonian to lower Mississippian Earn Group.
- Middle and Upper Cambrian rocks exhibit abrupt facies changes in the map area. Carbonates, up to 1500 metres thick in some thrust panels, are absent within a central thrust sheet and are replaced by fine siliciclastics, suggesting a shale-out.
- A belt of Earn Group rocks to the south, in the Driftpile Creek area has, been shown to extend into, and beyond the map area.
- Several new minor barite-sulphide occurrences have been discovered within the Earn and Road River groups.

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